

---

# **PROPULSION DIRECTORATE**

## **Monthly Accomplishment Report April 2003**

---



<b><u>Contents</u></b>	<b><u>Page</u></b>
<b><i>Rocket Propellant Breakthrough .....</i></b>	<b><i>1</i></b>
<b><i>PR &amp; NASA to Perform Risk Reduction Work for RS-84 Rocket Engine .....</i></b>	<b><i>1</i></b>
<b><i>PR Plays Crucial Role in Success of High Cycle Fatigue Conference .....</i></b>	<b><i>2</i></b>
<b><i>In-House Team Honored for Achievements in Fan Testing .....</i></b>	<b><i>3</i></b>
<b><i>Ketsdever Recognized for Contributions to Spacecraft Propulsion.....</i></b>	<b><i>4</i></b>
<b><i>High Power Photoconductive Switch Successfully Fabricated .....</i></b>	<b><i>5</i></b>
<b><i>PR Captures Best Presentation Awards from Local Symposium .....</i></b>	<b><i>6</i></b>
<b><i>Ruderman Recognized for Work on Rocket Motor Aging.....</i></b>	<b><i>6</i></b>
<b><i>Vukson Honored for Leadership in Battery Development .....</i></b>	<b><i>7</i></b>
<b><i>Spotts and Williams Share Directorate Honors for March .....</i></b>	<b><i>7</i></b>
<b><i>Student Researcher Captures Prestigious Fellowship .....</i></b>	<b><i>8</i></b>

ROCKET PROPELLANT BREAKTHROUGH: On 10 April 2003, Atlantic Research Corporation (ARC) successfully demonstrated a new gas generator propellant developed for the Propulsion Directorate's High Performance Post Boost Control System (PBCS) Components Program.



A new gas generator propellant for the Post Boost Control System (PBCS) Components Program is tested

ARC fired the propellant in a heavyweight test motor, demonstrating its performance over the large pressure range necessary for a valved solid gas generator system. The new propellant exceeded all the performance requirements of the program, including a cost reduction of over 65% compared to the state-of-the-art propellants. This propellant test completes the propellant development effort portion of the PBCS Program. This propellant will be used throughout the upcoming hot-fire tests to demonstrate other components of the system. (Lt Col M. Ward, AFRL/PRS, (661) 275-5230)

PR & NASA TO PERFORM RISK REDUCTION WORK FOR RS-84 ROCKET ENGINE: A team consisting of the Propulsion Directorate and NASA Glenn Research Center has been selected by NASA Marshall Space Flight Center and Boeing/Rocketdyne to conduct risk reduction studies for the RS-84 rocket engine program. These studies will focus on the heat transfer and thermal decomposition behavior of ultra-low sulfur kerosene in an effort to identify the role of sulfur and dissolved oxygen levels. In addition, a promising new copper alloy, GRCop84, will be evaluated for compatibility with the fuel. PR's Aerophysics (AFRL/PRSA) and Fuels (AFRL/PRTG) Branches have already undertaken efforts to identify fuel constituents and acceptance test methods. The results of these studies will aid in the identification of a new grade of RP-1, a liquid hydrocarbon rocket propellant, with greater thermal survivability for use with next generation, reusable hydrocarbon rocket engines. The RS-84 is currently being developed by Rocketdyne Propulsion and Power, a business unit of Boeing Integrated Defense Systems' Launch and Satellite Systems. It is a new reusable rocket engine that will generate more than one million pounds of thrust (at sea level). This engine is being developed to meet NASA's crew safety goals with a highly reliable and low cost main engine as a part of the Next Generation Launch Technology Program. (R. Bates, AFRL/PRSA, (661) 275-5664)



RS-84 rocket engine

*Want more information?*

❖ A Boeing article on the RS-84 is available by clicking [here](#).

PR PLAYS CRUCIAL ROLE IN SUCCESS OF HIGH CYCLE FATIGUE CONFERENCE:

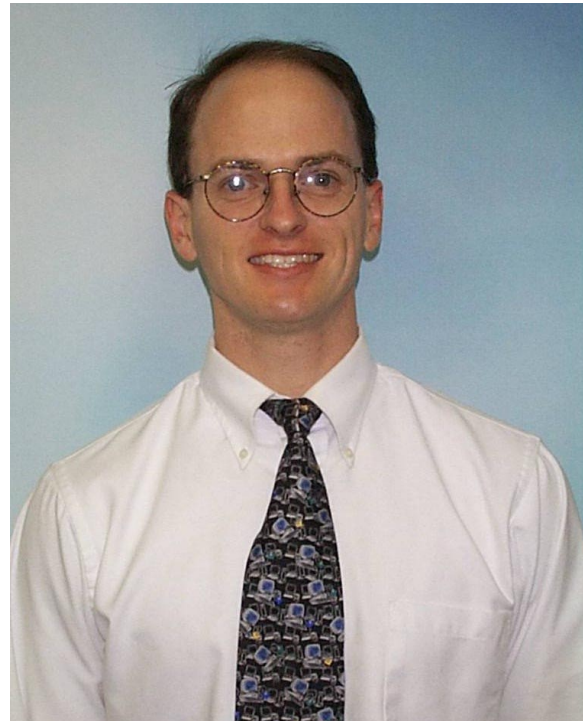
The Propulsion Directorate played a central role in the success of the 8<sup>th</sup> National High Cycle Fatigue Conference held in Monterey, California, from 14-16 April 2003. High Cycle Fatigue (HCF) is a widespread phenomenon in aircraft gas turbine engines that historically has led to the premature failure of major engine components (e.g., fans, compressors, turbines) and in some instances has resulted in loss of the total engine and aircraft. HCF is caused by vibratory stress cycles induced from various aeromechanical sources at frequencies which can reach thousands of cycles per second. The National HCF Science & Technology Program officially began in December 1994 with the purpose of eliminating HCF as a major cause of engine failures. The HCF Program is directed by an Air Force led Steering Committee consisting of representatives from the Air Force, Navy, Army, and NASA, along with an adjunct Industry Advisory Panel. The HCF Conference provides a valuable opportunity for information exchange on the status, plans, accomplishments, and execution of the HCF Program between participants from government, industry, and academia. For this year's conference, PR's Capt Brian Beachkofski served as the Deputy Chair, PR's Mr. Jeff Brown served as the Technical Program Chair, and more than half of the Program Organizing Committee was made up of PR personnel. The conference featured more than 85 technical presentations spread across 15 technical sessions, 5 of which were chaired by PR personnel. In addition, PR's Mr. Daniel Thomson, the HCF Program Manager, presented an "HCF Program Overview" during the introductory session of the conference. (Capt B. Beachkofski, AFRL/PRTC, (937) 255-7219)

Want more information?

- ❖ The website for the HCF Conference can be accessed by clicking [here](#).



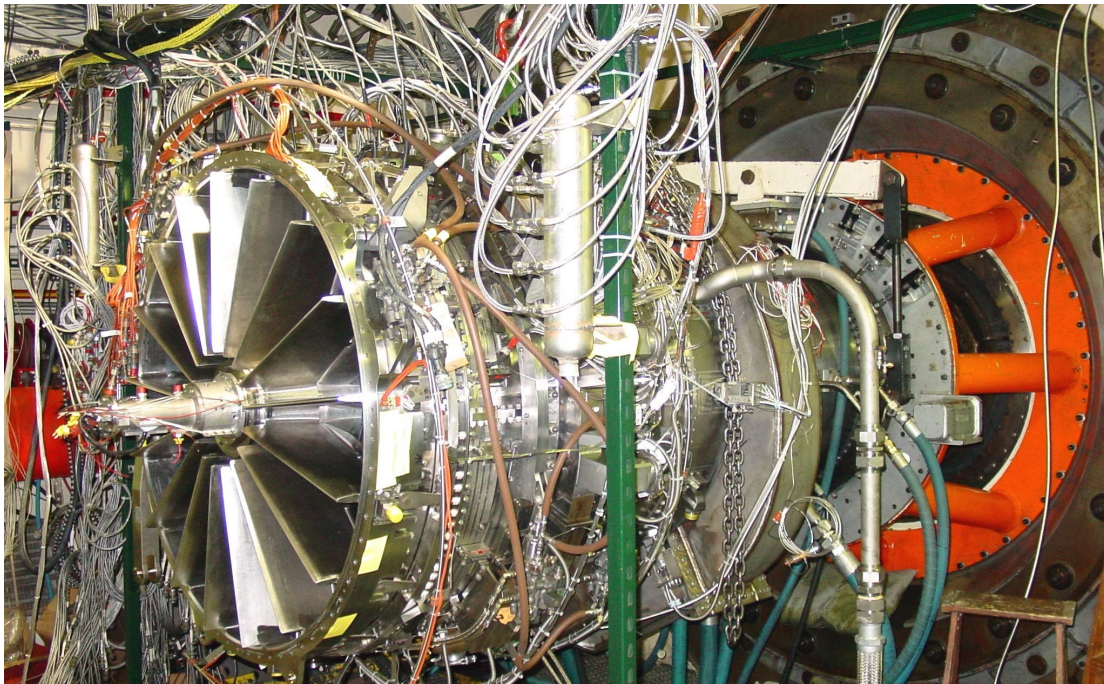
Capt Brian Beachkofski was the Deputy Chair for the HCF Conference



Mr. Jeff Brown was the Technical Program Chair for the HCF Conference



IN-HOUSE TEAM HONORED FOR ACHIEVEMENTS IN FAN TESTING: A Propulsion Directorate in-house team recently made contributions that were vital to the successful demonstration of the Integrated High Performance Turbine Engine Technology (IHPTET) XTE67/1 three-stage fan. This team made modifications to the Compressor Research Facility (CRF) at Wright-Patterson AFB, Ohio, which demonstrated innovation in the facility, test article, and compressor technology areas. Requirements for the XTE67/1 program dictated that a heated inlet capability be developed for the CRF. A \$1.5M facility upgrade was designed and implemented by the team to direct, mix, and throttle compressor discharge air back into the inlet. This semi-closed loop operation delivers up to 750°F air to the compressor. Included in the effort was an upgrade in the test cell's fan discharge temperature capability from 500°F to 1200°F. This design allows affordable heated inlet capability with minimal safety concerns, and the first time operation of the system during the XTE67/1 test program proved to be sound. The team also installed a high capacity, low footprint digital data acquisition system and an advanced high load capacity, 25,000 horsepower interface bearing system. These systems all performed flawlessly during the test period, thereby enabling the demonstration of the most technologically advanced and largest fan ever demonstrated in the CRF. Following on this success, the "CRF XTE67/1 Fan Test Achievements" project was named PR's In-House Project of the Quarter for the 1<sup>st</sup> Quarter of FY03. The team of Mark Reitz, Jason Parson, Dave Chaboty, John Stauffer, Gary Ostdiek, David Jay, John Lueke, Carlos Cardoza, and Ben Elkins (retired) was recognized with Notable Achievement Awards for their contributions to the project. (W. Copenhaver, AFRL/PRTF, (937) 255-7071)



The XTE67/1 fan on the test stand



Inlet heater system

KETSDEVER RECOGNIZED FOR CONTRIBUTIONS TO SPACECRAFT PROPULSION: The Propulsion Directorate's Dr. Andrew D. Ketsdever was recently selected to receive the Exemplary Civilian Service Award. Dr. Ketsdever was recognized for his distinguished service as Research Aerospace Engineer and Nonequilibrium Flow Research Team Leader for PR's Space and Missile Propulsion Division (AFRL/PRS) at Edwards AFB, California, from 1 October 2001 to 31 October 2002. Dr. Ketsdever consistently demonstrated his extraordinary commitment to perform above and beyond expectations in several complex, interrelated, multidisciplinary technical areas. He demonstrated two novel diagnostic techniques that will advance the state of the art in spacecraft-thruster interaction and micropropulsion research. These techniques were a nano-Newton Thrust Stand, used to measure thrust levels as low as 80 nano-Newtons, and a micro-spacecraft contamination monitoring system based on fiber optic technology. Dr. Ketsdever was also awarded



Dr. Andrew Ketsdever was selected to receive the Exemplary Civilian Service Award



a patent for his groundbreaking work on the Free Molecular Micro-Resistojet (FMMR), a novel Micro-Electro-Mechanical Systems (MEMS) fabricated thruster. His efforts resulted in the early transition of a FMMR device to Arizona State University (ASU) in time to be included in the ASU micro-satellite scheduled to be flown in 2003 from the Space Shuttle. This project also demonstrated his outstanding mentoring skills, as under his tutelage, a University of Southern California student won an international student award (International Astronautics Federation) and a major US award for aerospace engineering undergraduate students (AIAA Student Competition). In addition, Dr. Ketsdever is very active in professional societies, and is nationally and internationally recognized for his expertise in plume spacecraft contamination and micro-fluidics. Dr. Ketsdever is well deserving of this special recognition for his many noteworthy accomplishments. (J. Levine, AFRL/PRSA, (661) 275-6179)

**HIGH POWER PHOTOCONDUCTIVE SWITCH SUCCESSFULLY FABRICATED:** A planar-structure photoconductive semiconductor switch (PCSS) was successfully fabricated on high-resistivity 4H-SiC material. This Propulsion Directorate in-house PCSS work was performed in collaboration with research teams from Virginia Commonwealth University and the University of Southern Florida. The PCSS is an important type of electronic device that excels in applications requiring high voltage and high speed. Some of the applications of the PCSS include high-speed photodetectors, high-voltage pulse generation, and electron-beam pumped lasers. There is strong interest in developing these devices for use in high-power and high-temperature applications. This particular device was tested for operation as a high speed switch, with 2  $\mu$ -second rise time, dc operational blocking voltage up to 1000 volts dc, and switching current up to 50 A. The device performed with very low leakage current and low on-state resistance, with an off-state to on-state impedance ratio of  $3 \times 10^{11}$ . These excellent results are in part due to removal of the surface damage by high-temperature hydrogen atom etching and surface preparation. Atomic Force Microscopic images showed that very good surface morphology, atomic layer flatness, and large step width were achieved by atomic hydrogen post-processing. A journal article describing these results has been accepted for publication in the *Applied Physics Letters*.\* (B. Ganguly, AFRL/PRPE, (937) 255-2923)

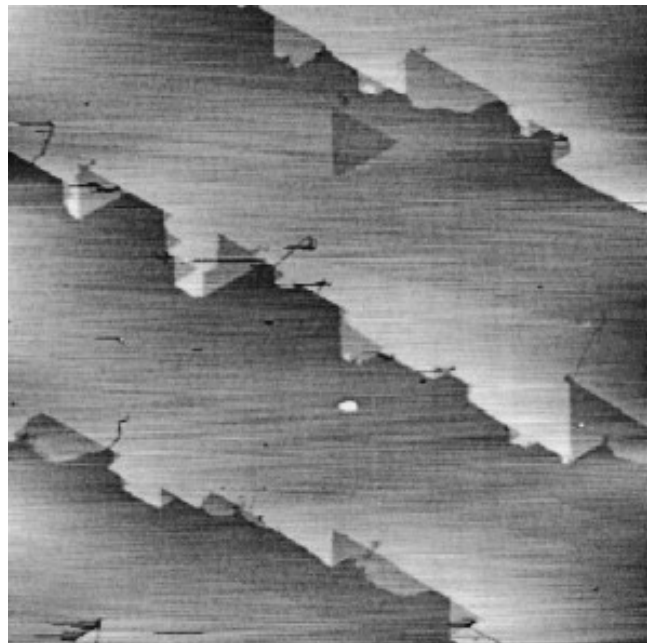


Image of the 4H-SiC material after etching

---

\* S. Doğan, A. Teke, D. Huang, H. Morkoç, C.B. Roberts, J. Parish, B. Ganguly, M. Smith, R. E. Myers, and S. E. Saddow, "4H-SiC Photoconductive Switching Devices for Use in High-Power Applications," *Applied Physics Letters*, Vol. 82, No. 18, May 5, 2003, pp. 3107-3109.

**PR CAPTURES BEST PRESENTATION AWARDS FROM LOCAL SYMPOSIUM:** Winners of the Best Presentation Awards from the 28<sup>th</sup> Annual Dayton-Cincinnati Aerospace Science Symposium were recently announced, and the Propulsion Directorate played a part in three of the 13 award winning presentations. Sukesh Roy of Innovative Scientific Solutions, Inc. (ISSI) won for his presentation titled “Dual-Pump Dual-Broadband Coherent Anti-Stokes Raman Scattering for the Measurement of Temperature and Multiple Species Concentrations” in the Combustion Diagnostics, Sensors, and Instrumentation category. Co-authors on this presentation included Terrence R. Meyer and Michael S. Brown of ISSI, Robert P. Lucht of Purdue University, and James R. Gord, Vincent M. Belovich, and Edwin Corporan of the Propulsion Directorate. Michael S. Brown of ISSI won for his presentation titled “OH-Based Fuel/Air Ratio Monitor for the Pulsed-Detonation Engine” in the Fuels, Combustion Systems, and Pulsed Detonation Engines category. Co-authors on this presentation included Terrence R. Meyer, John L. Hoke, and Jason T. Parker of ISSI as well as James R. Gord and Frederick R. Schauer of the Propulsion Directorate. Finally, Michael Barringer of Virginia Tech University took the honors in the Turbomachinery category for his presentation titled “Developing a Combustor Simulator for the Turbine Research Facility.” Co-authors on this presentation included Karen A. Thole of Virginia Tech and Marc D. Polanka of the Propulsion Directorate. The annual Dayton-Cincinnati Aerospace Science Symposium is sponsored by the American Institute for Aeronautics and Astronautics. This year’s event was held on 4 March 2003 in Dayton, Ohio. (J. Zelina, AFRL/PRTS, (937) 255-7487)

**Want more information?**

- ❖ More information on this event can be found at the AIAA Dayton-Cincinnati Section’s webpage located [here](#).
- ❖ A list of the award winning presentations is available by clicking [here](#).

**RUDERMAN RECOGNIZED FOR WORK ON ROCKET MOTOR AGING:** The Propulsion Directorate’s Dr. Gregory Ruderman was recently selected to receive the Exemplary Civilian Service Award. Dr. Ruderman was recognized for his distinguished service as program manager of the Critical Defect Assessment (CDA) and Service Life Prediction Technology (SLPT) Programs for PR’s Space and Missile Propulsion Division (AFRL/PRS) at Edwards AFB, California, from 1 March 2001 to 31 October 2002. During this period, Dr. Ruderman expertly led a team of scientists and engineers that developed advanced analytical and experimental techniques in the field of solid rocket motor aging and surveillance. These models and associated validation methods represent the forefront in predictive tools that are



Dr. Gregory Ruderman was selected to receive the Exemplary Civilian Service Award

central to the efficient development, evaluation, implementation, and surveillance of high performance solid rocket motor technologies of the future. Dr. Ruderman's outstanding contributions to the development of solid rocket motor aging and surveillance technologies have been critical for the implementation of advanced diagnostics and in situ sensors for the next generation of strategic and tactical missiles. Successful incorporation of imbedded sensors into solid rocket motors will provide the warfighter with real-time health monitoring of missile propulsion systems, enable identification and removal of suspect motors in the field, and significantly reduce system life cycle costs. Dr. Ruderman's proactive leadership has ensured that the CDA and SLPT Programs are focused on technology transition to the warfighter. His superior leadership of AFRL's aging and surveillance modeling and validation efforts has made significant contributions to the state of the art of aging and surveillance for future US strategic and tactical weapons systems. (K. McFall, AFRL/PRSB, (661) 275-5450)

VUKSON HONORED FOR LEADERSHIP IN BATTERY DEVELOPMENT: The Propulsion Directorate's Mr. Stephen P. Vukson was recently selected to receive the Exemplary Civilian Service Award. Mr. Vukson was recognized for his distinguished performance as the Deputy Program Manager for the joint AFRL/NASA/Army Lithium Ion Battery Development Initiative from 1 June 1997 to 30 October 2002. This initiative addresses fundamental electrochemical research and development, cell and battery design, investigation of charge control methodology, and engineering scale-up of cell sizes ranging from 5 to 200 ampere-hours. Mr. Vukson provided exemplary technical leadership and extraordinary managerial expertise to ensure that this joint technology maturation initiative reduced risk for future Air Force, Army, and NASA missions. As the Deputy Program Manager, Mr. Vukson was directly responsible for all administrative aspects of soliciting, evaluating, and ensuring the timely award of multiple contracts. As a direct result of his commitment to this initiative, four contractual efforts were procured at a value in excess of \$28M. In addition to serving as the Deputy Program Manager for this major initiative, Mr. Vukson also serves as Program Manager for the ~ \$17M Yardney contract being executed under this initiative. The Lithium Ion Battery Development Initiative has accomplished numerous key risk reduction efforts and transitioned technology into numerous systems. Cells and batteries were designed, fabricated, and tested in accordance with NASA mission requirements for Mars Landers and Rovers. Similarly, the Air Force has transitioned this technology to the B-2 main aircraft battery and the Army is in the process of transition for key ground applications. Mr. Vukson is well deserving of this recognition for his contributions to these successes. (J. Erbacher, AFRL/PRPS, (937) 255-2372)

SPOTTS AND WILLIAMS SHARE DIRECTORATE HONORS FOR MARCH: Ms. Deborah Spotts and Ms. Lori Williams were named co-winners of the Propulsion Directorate's Employee of the Month Award for March 2003 in the Staff Support/Technician Category. **Ms. Spotts** was recognized for her efforts supporting the rapidly growing Small Business Innovation Research (SBIR) program at PR's Edwards Research Site. Between FY02 and FY03, the SBIR program at PR-West grew dramatically, from 24 Phase I awards in FY02 to more than 100 in FY03. To reduce the burden associated with this fourfold increase in SBIR activity, Ms. Spotts has worked diligently to streamline acquisition processes and train program managers on these processes. Furthermore, she has worked in support of the Airborne Laser (ABL) Program at the Air Force Flight Test Center, resulting in PR managing two ABL SBIR programs and generating several



new topics for the FY04 solicitation. **Ms. Williams** was recognized for her efforts as a member of PR's Financial Management Division (AFRL/PRF) at Edwards AFB, California. She serves as the single point of contact for Defense Finance and Accounting Service (DFAS) issues, which has resulted in tremendous man-hour savings across PRF. She also handles a wide variety of other responsibilities, such as civilian pay analysis, indirect rate analysis, and on-site support contract data, as well as a host of special requests and one-time requirements. Furthermore, she has developed and edited documentation covering nearly every aspect of the PRF operation and is an expert on many of PRF's critical systems (e.g., JOCAS, ABSS, etc.). (K. VanderHyde, AFRL/PROI, (661) 275-5377 and D. Harder, AFRL/PRF, (661) 275-6390)



Ms. Deborah Spotts (left) and Ms. Lori Williams (right) were selected as co-winners of PR's Employee of the Month Award for March 2003

**STUDENT RESEARCHER CAPTURES PRESTIGIOUS FELLOWSHIP:** Mr. David Scharfe, a University of Southern California undergraduate student, recently received a prestigious DoD National Defense Science and Engineering Graduate (NDSEG) Fellowship. Mr. Scharfe has been performing research under the tutelage of Dr. Andrew Ketsdever of the Propulsion Directorate's Aerophysics Branch (AFRL/PRSA). Mr. Scharfe has been engaged in work on gas flows through nano-porous materials. This research is of interest to AFRL/PRSA for a variety of nano-scale applications. The NDSEG Fellowship is being administered through the Air Force Office of Scientific Research. (A. Ketsdever, AFRL/PRSA, (661) 275-6242)